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Assessment of Cooperation Mechanism options

Cost-Efficient and Sustainable Deployment of Renewable Energy Sources towards the 20% Target by 2020, and beyond. D3.2

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PREFACE/ACKNOWLEDGEMENTS

This document reports activities and results of Task 3.2 of the Intelligent Energy Europe supported project RES4Less. Furthermore, fruitful inputs have been obtained in the stakeholder workshops carried out within the RES4Less project. Additionally, the topic has been presented and debated at two international conferences.

The results were also shared and enriched by comments from other members of the RES4Less Team during internal meetings of the project.

EXECUTIVE SUMMARY

The RES Directive 2009/28/EC (European Commission 2009) set legally binding targets for EU Member States on energy consumption from renewable sources – the 2020 RES targets. A part of this can be achieved through the use of cooperation mechanisms: statistical transfer, joint project and joint support schemes. The intention of the cooperation mechanisms is to provide the flexibility needed to achieve Europe's renewable energy targets in a more cost-efficient way. In Task 3 of the RES4Less project we analyse the benefits and challenges of using the two cooperation mechanisms: joint project and joint support schemes. A first report (Pade Hansen & Klinge Jacobsen, 2012) analysed the barriers for using the cooperation mechanisms. This report is the outcome of the work in Task 3.2 where we analyse how the barriers can be overcome and how different design options can be used under varying conditions and time horizons.

Cooperation mechanisms have the potential to reduce the compliance costs of reaching the 2020 RES targets for EU member states. The largest benefits can be achieved under full harmonisation and one joints support scheme. However, the different national objectives along with uneven distribution of benefits and costs make this unrealistic in the near future. Cooperation between pairs or groups of countries with large net benefits that can be relatively easy estimated and shared is attractive and realisable in a shorter time horizon.

Joint project cooperation is the most flexible instrument to use as it preserves the national legislation and support schemes (national objectives) and can be easily scaled in size. The drawback is the high transaction costs and some uncertainty regarding which party should carry the project implementation risk and guaranty the support for the projects for the entire lifetime. The joint projects can be realised in a short term horizon and as such pave the way for further cooperation. Large projects has a considerable advantage in the reduced transaction cost relative to project size and governments can be expected to be more willing to spend resources negotiating these. If the benefits should be exploited at a larger scale for smaller projects it is necessary to create standardised joint projects or a joint project support framework. This implies governments agreeing on standardised support and compensation terms along with sharing agreements on the volume risk of realised RES generation in 2020.

Joint support schemes have the largest cost reducing potential but are also the most demanding regarding the conditions and common objectives of cooperating countries. Countries that have existing support schemes that are similar (for example green certificates) or at least don't have conflicting objectives of the support are the most likely to engage in this type of cooperation. Also a common electricity market reduces the barriers associated with addressing indirect effects as the cooperating countries will experience similar effects. For example, the addition of more zero marginal cost renewable capacity will affect the market price identically in an integrated electricity market independent of the location of the new capacity. The existing generators will thus also experience the price and revenue effect they would have been exposed to anyway.

Finally we suggest that also the option of technology or geographically specific joint support schemes are considered. This more limited type of joint support scheme could be applied where there are more conflicting national ambitions or objectives for renewable energy policies but certain cost reducing options that can be jointly exploited. This may be a joint

support scheme as a fixed feed-in for one specific technology for example PV or offshore wind or a regional cooperation where tenders for RES are held jointly and credits shared independently of where in the region the actual capacity is build.

This report also emphasizes the importance of risk as a barrier for engaging in cooperation. The uncertainty regarding the future RES targets will make countries reluctant to let other countries exploit their lowest cost excess RES options. These might be needed if countries have to comply with stricter European RES targets after 2020. On the other hand countries will be reluctant to finance RES technologies in other countries that have a long lifetime if they only need the RES generation to count towards their 2020 RES target compliance.

Facing this uncertainty countries with different expectations about future targets or with national RES target policies for the post 2020 might benefit from cooperating. A possible user country for 2020 compliance faces two different options:

I. User country acquire the full RES **capacity** credits necessary to generate for 2020 compliance: User country finances the entire support cost for lifetime of the RES capacity
Generation from the capacity counts towards the user country post 2020 targets (reduced risk)

II. User country acquires only the generation credits necessary for 2020 compliance.
Generation from capacity counts towards the host country future obligations. User country has the full risk on post 2020 compliance

Option II is relevant only if the host country wants to retain its excess RES resources for future compliance with stricter EU targets or for national ambitions exceeding the targets set by the EU for 2020. The user country will find this an option if it do not expect that the future RES targets will be stricter or it is expected that in the future other cheap resources for compliance through national implementation or cooperation will become available. As such option II could serve in the short term to overcome some of the barriers associated with the uncertainty about future EU RES targets.

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1 INTRODUCTION

The RES Directive 2009/28/EC (European Commission 2009) sets legally binding targets for EU Member States on energy consumption from renewable sources – the 2020 RES targets. A part of this can be achieved through the use of cooperation mechanisms: statistical transfer, joint project and joint support schemes. The intention of cooperation mechanisms is to assure the flexibility needed to achieve Europe's renewable energy targets in the most cost-efficient way.

The EU 2020 member state (MS) targets for renewable energy are based on the national shares in 2005. The required total addition of renewable energy for the EU has been distributed among the member states taking very few parameters into account (Klessmann et al 2010). One parameter considered is the income level, thereby putting a slightly higher burden on wealthier countries. However, the differences in costs of implementing renewable investments for member states has not been directly included in setting the targets, so there is no consideration for cost efficient implementation. Therefore there exists a potential for reduced compliance costs for countries through implementing their targets jointly. These benefits can be realised by using cooperation mechanisms. Current EU legislation has opened for using joint support schemes, joint projects and statistical transfers as support for promoting renewable energy to meet the 2020 targets, but the details for these mechanisms have not been laid out.

The least complicated mechanism is *statistical transfer*, an ex-post transfer of virtual RES certificates that can be used for target compliance. This mechanism depends directly on governmental involvement and can also be associated with the other mechanisms at the final stage of transferring the achieved RES certificates from one country to another. Alone, statistical transfer does not induce additional RES development since no prior agreements assure the sale of the credits and therefore it has limited use as promoting a more efficient distribution of RES development. Due to the incentive structure behind this mechanism, it is expected that only very limited 'statistical transfer'-volumes will be available to MS for complying with their target in 2020 (Klessman et al 2010). If this mechanism should be used as strategic instrument rather than as an ad-hoc means of 'filling the gaps', MS would have to guarantee the delivery of RES certificates under a statistical transfer several years prior to 2020, so that the receiving MS can avoid the development of own RES production. However, many MS, especially those using feed-in tariffs or other non quantity-driven support systems, will not be able to guarantee delivery long before 2020, as they will be uncertain in regards to their own target compliance. Therefore sharing of compliance risk would be a critical issue in agreements on statistical transfers ex ante.

The mechanism of *joint projects* gives those MS that lack sufficient low-cost RES potential (user country) the possibility to develop projects in another MS (host country). In this case the user country would support investors in undertaking the project or investors are supported jointly by the two countries and then the total costs are balanced via a compensation scheme. MS can either cooperate on a project-to-project basis or agree on a special support framework for a number of projects. These special support frameworks can be defined for a certain technology or a certain area, and can be implemented in parallel to existing national support schemes. In the medium to long term, the cooperation on special support frameworks might lead to a further expansion of the cooperation itself (i.e. through standardisation), and therewith lead to the development of joint support schemes.

The mechanism of *joint support schemes* is a broad cooperation of MS on a national level and may pave the path towards harmonisation in the long run. In this case the MS agree on a common support scheme. The introduction of a common support scheme gives the greatest potential to efficiently utilise RES potential in the involved MS, as the establishment of equal incentives will ensure the development of RES at the most beneficial sites in the cooperation area. A less ambitious option is that the MS partially coordinate their national support schemes, such that the common support scheme only applies to specific technologies, or to specific areas. These possibilities will be dealt with in more detail in Task 3.2 of the RES4Less project, but the barriers are treated in this report.

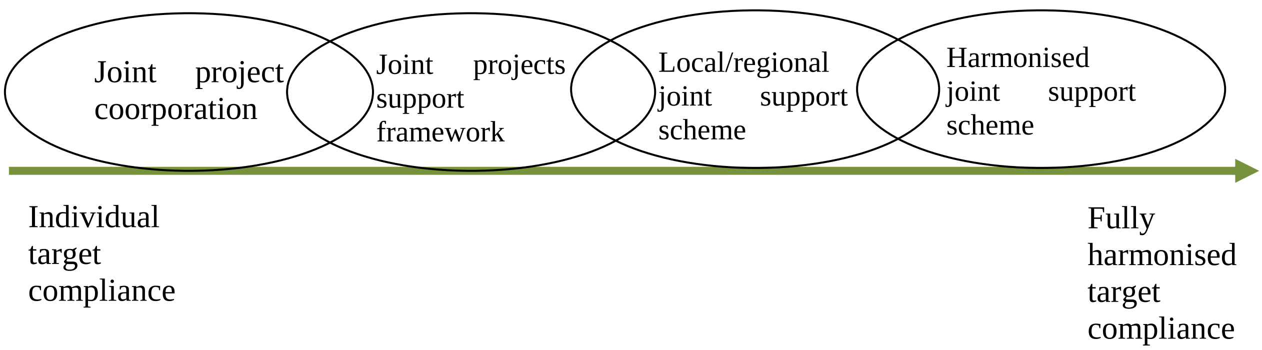
In Table 1-1 the main characteristics of the three cooperation mechanisms are summarized.

Table 1-1 Cooperation mechanisms and their main characteristics

Statistical Transfer	Joint Project	Joint support scheme
Ex-post transfer of virtual RES certificates	Gives MS that lack sufficient low-cost RES potential the possibility to develop projects in another MS	Broad cooperation of MS on a national level
Does not induce additional RES development	MS can either cooperate on a project-to-project basis or agree on a special support framework for a number of projects	MS agree on a common support scheme – fully (cover all technologies and areas) or partially (only covers specific technologies, or to specific areas)
	Support frameworks can be defined for a certain technology or a certain area	Gives the greatest potential to efficiently utilise RES potential in the involved MS

The cooperation mechanisms actually implemented might be somewhere in between, as they may contain elements from both types. If, e.g., two countries agree on a common tender for an offshore wind farm supported by a price premium are we then dealing with a joint support scheme or a joint project? The fact that it is a limited project – the offshore wind farm – makes it a joint project, whereas the support scheme – the price premium – makes it a joint support scheme. The range from individual target compliance over joint projects to joint support schemes and the fully harmonised target compliance is illustrated in Figure 1-1.

Figure 1-1 Levels of cooperation from individual target compliance to fully harmonised system



In Task 3 of the RES4Less project we analyse the barriers for two of the cooperation mechanisms: joint projects and joint support schemes. We do not address the Statistical Transfers since the barriers and the complexities related to statistical transfers initially in the project definition were assumed to be very limited. Furthermore, transfers do not provide more efficient RES development but only exploit ex post surpluses. This report is the outcome of the work in Task 3.2 with the purpose of analysing the two cooperation mechanisms individually, identifying the specific barriers prevailing to the two mechanisms and finally identify solutions for these barriers. We take the point of departure in the benefits and costs associated with cooperation in general (Section 2) and then turn to the two cooperation mechanisms, first the joint support scheme (Section 3) and then joint project (Section 4). Furthermore, we analyse possible interactions between the RES targets with associated cooperation mechanisms, and CO_2 targets with a CO_2 quota market, for example the European ETS (Section 5). Finally we conclude (Section 6).

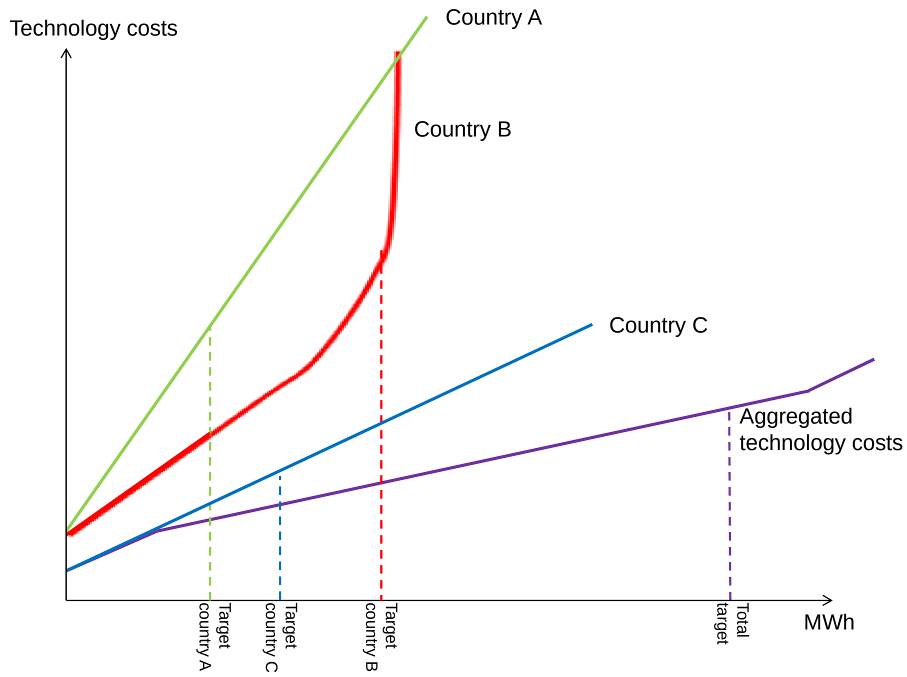
2 BENEFITS AND COSTS FROM COOPERATION

The basic precondition for countries to engage in cooperation is that both/all have to benefit from it. First of all the total benefits from cooperation have to exceed the total costs, secondly, the countries have to be able to agree on some sort of compensation scheme to share the benefits and costs such that both/all countries experience a net benefit. We distinguish between the direct costs and benefits and the indirect costs and benefits.

2.1 Direct benefits

The direct benefits relate to the total reduced compliance costs achieved from cooperation. The RES targets defined in the Directive (European Commission 2009) do not take the economic and technical potential of renewable energy sources for the countries into account, but only consider the existing level as well as the income of the countries. Therefore, there is in the nature of the individual targets an opportunity to decrease the aggregated costs of compliance for the entire EU by cooperating, if countries with expensive RES potentials are allowed to install RES in countries with cheaper RES potentials. This can be illustrated in the following illustrative example. Figure 2-1 showing the technology costs for three countries, A, B and C, and the aggregated technology costs curve for the three countries.[1] Furthermore, the three countries' individual targets as well as the total target are indicated.

Figure 2-1 Technology costs and aggregated technology costs for three countries



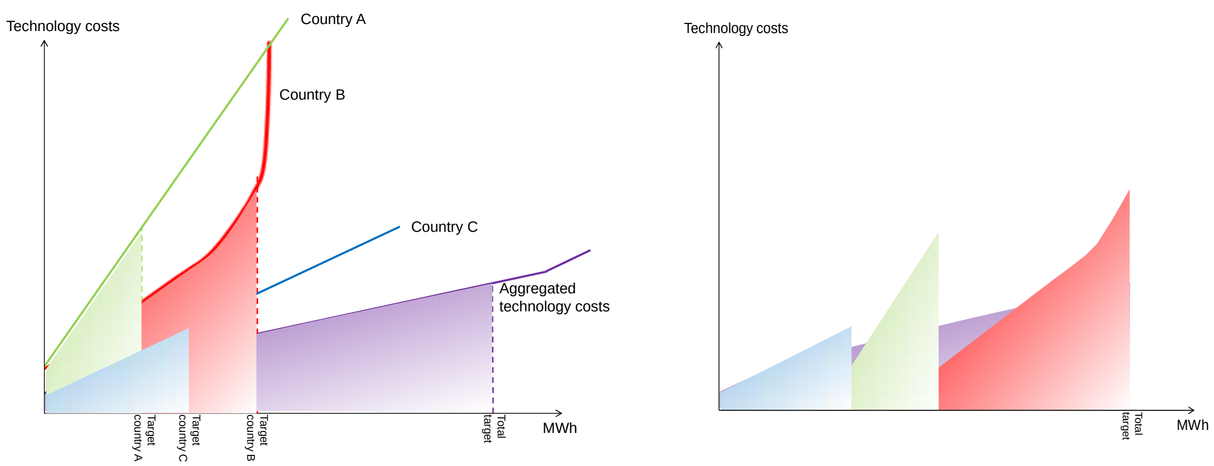
The Figure illustrates that country A have steeply increasing technology costs whereas country B has more moderate costs until a certain point where the costs increase dramatically corresponding

[1] A slightly different analysis has been carried out in Dalla Longa and Bole-Rentel T (2011). Unlike the analysis in Dalla Longa and Bole-Rentel T (2011) the present analysis is regarding the overall technology costs and targets and does not consider the excess potentials and stated valleys of opportunity.

to a kind of limit of the resource. Country C on the other hand has rather modest technology costs increasing steadily with increasing production. The technology costs are given as production levels, corresponding to the targets assigned in the NREAP's (Beurskens et. al. 2011). The illustrative targets are set such that country A has a rather modest target whereas country B has a stricter target meaning that they would have to use resources with quite high technology costs. The target of country C is somewhere in between.

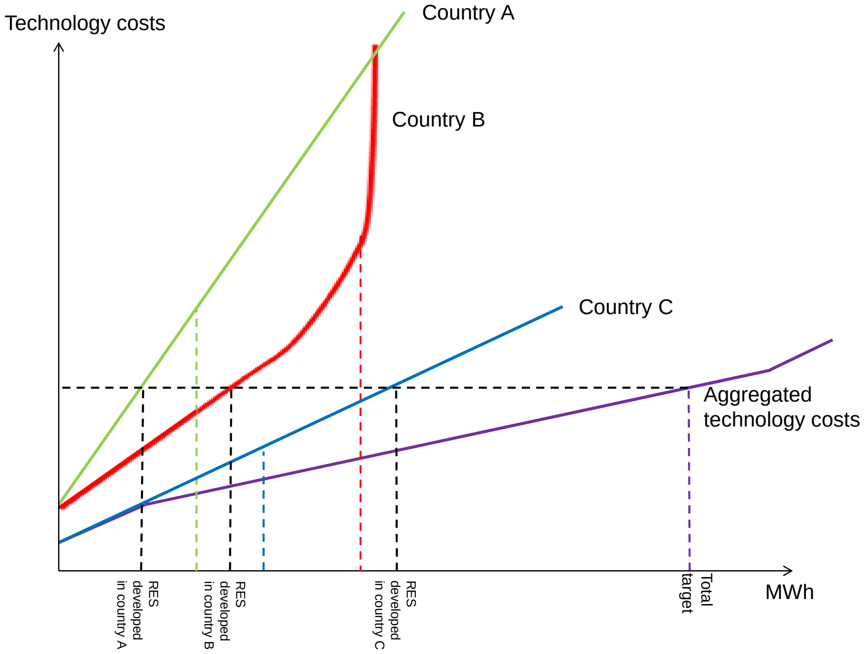
The benefits from cooperation for the three countries as a whole is illustrated in Figure 2-2 where the total costs from reaching the target is given by the shaded areas under the curves. From the right side of the Figure it is fairly easy to see that total compliance costs from the individual solution exceed the total compliance costs from the common solution.

Figure 2-2 Total compliance costs (shaded area, left), comparison of total costs individual vs. common target compliance (right)



A relative larger share of the RES will be developed in country C whereas the smallest share will be developed in country A. This is illustrated in Figure 2-3 showing that cooperation will lead to identical technology costs in the three countries whereas the development of RES will be reallocated relative to the initial individual targets. In this illustrative case most RES will be developed in country C and least in country A.

Figure 2-3 Allocation of RES development under cooperation



2.2 Direct costs

On the cost side the direct costs from cooperation will be related to grid reinforcement and grid expansion costs. Dependent on the extent to which the RES is installed where new capacity is required the additional reinforcement and grid connection costs will constitute a cost associated with cooperation.

In the situation that the RES developed under cooperation is not required by the host country, as sufficient capacity is already installed, the development of additional RES under cooperation will give rise to additional reinforcement costs and grid connection costs. Grid reinforcement will be necessary, as the extra power generated needs to be exported to other areas/countries when not needed in the country/areas where it is produced. Furthermore, the grid also needs to be reinforced in order to be able to handle large amounts of fluctuating electricity from RES if this characterises the RES technology mainly contributing.

Even when there is demand for the capacity installed under the cooperation scheme, the host country may still have costs associated with the distribution/export of electricity during periods of high production/low demand, and in providing sufficient alternative capacity given the inherent fluctuation of many renewable energy technologies.

2.3 Indirect effects

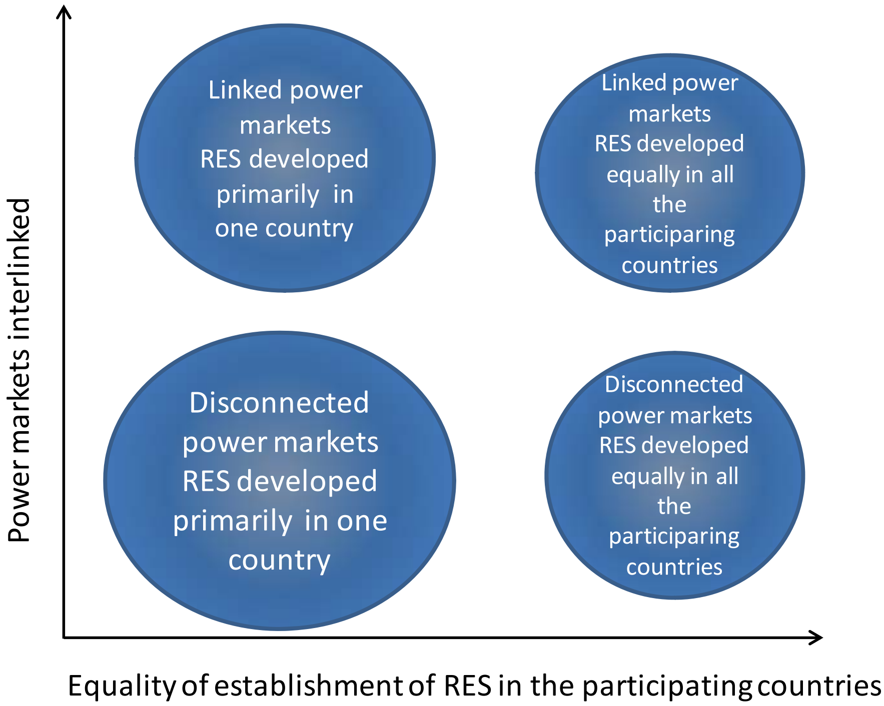
The indirect costs and benefits associated with cooperation will often be divided such that what occurs to be benefits for the country(ies) establishing the additional RES will be an indirect cost to the country(ies) that do not establish the extra RES and vice versa. Assume for example two countries are cooperating and the cooperation turns out such that the entire amount of RES is established in the one of the countries (host country) and only accounts for the RES targets of the other country (user country). In this case the host country will experience indirect benefits in terms of industrial and technological development, increased employment and health effects in terms of fewer local emissions. On the other hand, these are exactly the same effects the user country will miss and they will therefore occur as indirect costs of cooperation for the user country. The converse effect occurs for example in relation to the effects on the power market. In the host country the power market may be affected in undesirable ways as a consequence of the establishment of additional RES. These effects will count as indirect costs. In the same time, the user country will not meet these challenges and will therefore count the same effects as indirect benefits from cooperation. In the following we consider the indirect costs and benefits as indirect effects from establishing additional RES.

2.3.1 Power market effects

The effect on the power market is highly dependent on the extent to which the power markets of the cooperating countries are interlinked or not, and the extent to which the majority of the RES developed under cooperation is established in one of the countries or if the RES development is divided between the participating countries.[2] The four extreme cases, illustrated in Figure 2-4, shows that the possible combinations cover the situations from disconnected power markets where all the RES is developed in one country, to totally interlinked power markets where the RES is developed equally in the participating countries. The probability of the cases is illustrated by the size of the circle. In the following we concentrate on the two cases where the majority of the RES is developed in one of the countries under both assumptions of interlinked and disconnected power markets. The European power markets are in principle interlinked. However, due to capacity constraints the European power market is divided into sub-markets with each their individual price structure. These different price structures play a role when assessing the benefits and costs from cooperation.

[2] As the primary benefit from cooperation is expected to arise due to differences in technology costs it is most likely that the majority if not all the RES will be developed in one of the participating countries.

Figure 2-4 Possible combinations of level of power market interlink and equal RES development

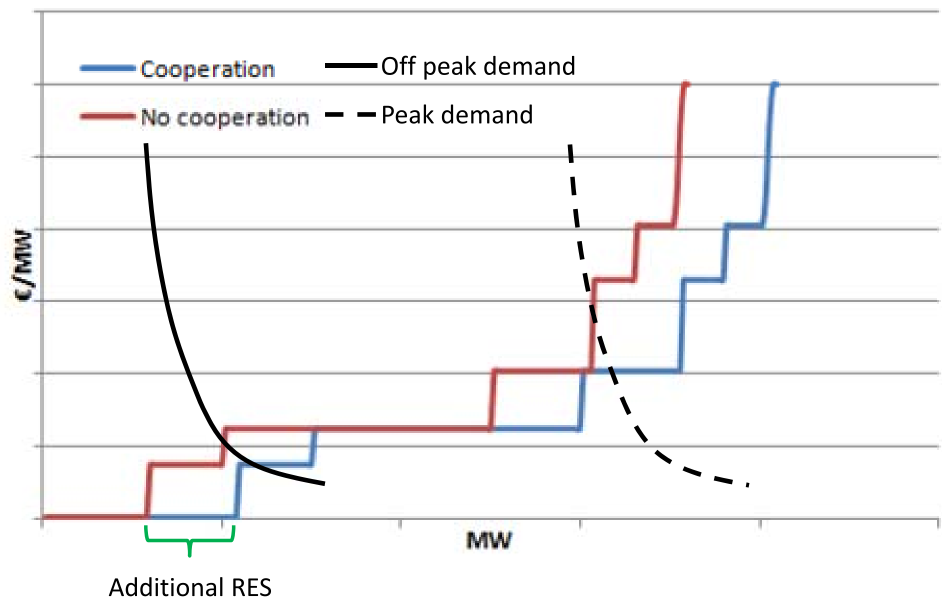


Interlinked power markets
When we assume that the power markets of the participating countries are interlinked the electricity will be sold on the same market at the same price. In this case cooperation will not have diverging impacts on the power market or power price between the host and user country. The indirect costs to either country in terms of power market effects are thus expected to be small. Investment incentives, changes in generation mix, generation efficiency and security of supply, will be equally affected in the two countries and since the combined market is larger these effects will also be much less than if isolated.

Disconnected power markets
When the power markets of the cooperating countries are not linked we have a totally different story. In this case there will be an effect in the country where the RES is primarily developed (host country), which again will affect the investment incentives for generators not subject to the cooperation. Furthermore, the generation mix, power generation efficiency and security of supply will be affected.

Depending on the size of the RES development relative to the existing electricity market, the additional RES will affect the average power price. In Figure 2-5 a possible effect of additional RES is illustrated. In this example the power price is hardly affected during off peak whereas the effect on the peak price is more significant resulting in a decreased average power price. Decreased power prices is as a point of departure a benefit to the electricity consumers whereas the producers will experience this as a loss. In particular, decreased power prices will affect the investment incentives in the host country and the host country will have to provide alternative ways to secure the incentives for future investment in conventional capacity. This will be perceived as an indirect cost to the host country and therefore as an indirect benefit for the user country.

Figure 2-5 Supply and demand curve, without and with cooperation



Furthermore, the expected reduced power price makes the least efficient base load plants less profitable or even loss making. This will eventually result in shut downs of these plants and the generation mix will consequently become less diversified and the sector becomes more vulnerable to changes in the prices of few or just one fuel, such as natural gas. Eventually, this development will affect the power sector such that it provides less security of supply for power. Less security of supply of power will be perceived as an indirect cost to the host country and should thus be treated similarly as an indirect benefit for the user country.

2.3.2 Technological development

When increasing the development of renewable energy as a consequence of cooperation, the host country may expect an increased technological development within the specific RES technology. The increase in the installed capacity is expected to lead to an increase in the research and development activities as well as learning effects and therefore faster technological progress in the host country (Bürer and Wurstenhagen, 2009, Lund, 2011, and Loiter and Norberg-Bohm, 1999). Increased technological progress may lead to increased export of the relevant technology and hence further contribute to economic growth. These indirect effects will be perceived as a benefit to the hosts country and simultaneously represent an indirect cost for the user country

2.3.3 Employment effects

The net-effect on the employment of increased RES development in a country is not absolutely certain. A number of studies (Lehr et al (2008), Mathiesen et al (2011), Blanco and Rodrigues (2009) and Hillebrand et al (2006)) argue that there are positive short run effects from installing renewable energy capacity. Additionally, the short term employment effects are often assumed to benefit more remote areas (Hanley and Nevin 1999). The long run effects are more ambiguous. Furthermore, the above mentioned increased technological development and possible export opportunities also has the potential of increasing the employment in the host country.

Despite that the employment effects from installing renewable energy are quite uncertain it is often used as an argument for supporting renewable energy. Therefore, the possible employment effects in the host country from RES supported by another country will be perceived as indirect benefits while the user country will perceive this as indirect costs. The affects on employment will need to reviewed on a case-by-case basis, and are dependent on the size and nature of the proposed development, the incumbent power generation infrastructure and associated workforce.

2.3.4 Environmental effects

The scope and magnitude of environmental effects as a result of cooperation is quite uncertain depending on the technologies involved. However, the environmental effects cover health effects connected to replacing power production based on fossil fuels with renewable energy. However, if the renewable energy technology is biomass the direction of the effects is ambiguous. The health effects from biomass combustion depend highly on the local population density, atmospheric conditions, and the biomass source. Large scale CHP using biomass generally emits much less particles etc than the alternative individual heating technology that in certain situations have serious effects on even air quality. In the situation with positive health effects from installing additional RES the country where the RES is installed will consider it an indirect benefit. The user country will consider this a loss of a potential benefit, i.e. an indirect cost from cooperation compared to importing the biomass and using it as RES.

3 JOINT SUPPORT SCHEME

The mechanism of *joint support schemes* is a broad cooperation of MS on a national level and represents the cooperation mechanism closest to harmonisation of support schemes among MS. In this case the MS agree on a common support scheme which gives the greatest potential to efficiently utilise RES potential in the involved MS, as the establishment of equal incentives will ensure the development of RES at the most beneficial sites in the cooperation area. A less ambitious option is that the MS partially coordinate their national support schemes, such that the common support scheme only applies to specific technologies, or to specific areas.

In the following sections we investigate the barriers that are specifically relevant for joint support schemes and attempt to identify solutions to these barriers. Furthermore we address specific cases such as the tradable green certificate scheme between Norway and Sweden, in order to investigate the extent to which barriers have been overcome in this case.

3.1 Barriers related to different support schemes

When two or more countries engage in a joint support scheme, one of the challenges is to agree on the relevant support scheme(s). Historically, the EU countries have been using numerous support schemes (Hass et al 2011) and have addressed several technologies. Table 2 in (Hansen & Klinge Jacobsen, 2012) shows which support schemes are applied for which technologies for a number of EU countries. The table shows that feed-in tariffs are very widespread but also that tradable green certificates (TGC) are widely used.

As the EU countries traditionally have been applying different support schemes for different technologies, the use of alternative support schemes as such is not expected to constitute a barrier for cooperation between countries. However, if countries already have implemented widely used support schemes for specific technologies, introducing another support scheme for the same technology may give rise to difficulties and challenges. Some support schemes may work perfectly together while others have different scopes and targets. Below the issues related to combining different support schemes are listed (Table 3-1).

Table 3-1 Combination of support schemes in host and user country

	Feed-in tariffs	TGC	Tendering	Feed-in premium
Feed-in tariffs	- Different levels of support - Different targeted technologies - Different support period and uncertainty	- Feed-in is technology-specific, TGC works best with competition and no technology differentiation - Different support level	- The two schemes are often used in combination for larger projects, where the needed feed-in tariff is the outcome of the tender	- Different support levels - Different targeted technologies - Different technological stage
TGC		- Different price levels, i.e. support levels - TGC may be general or only covering some technologies	- Tendering is technology-specific, TGC works best with competition - Tendering is used for large project, TGC is general	- Feed-in premium may or may not be technology specific, TGC enhance competition between technologies
Tendering			- Tendering used in	- Feed-in premium

			two countries do not necessarily differ. Procedures, support rules, network connection etc. are defined specifically for each tender. The tender outcome will not depend on whether the tender is called in more than one country.	could be general as well as technology specific, tender is mostly technology specific - The two schemes could easily be used in combination for larger projects, where the needed feed-in premium is the outcome of the tender
Feed-in premium				- Different levels of support - Different targeted technologies

The main barrier related to different support schemes when engaging in a joint support scheme may be the differences in the scope of different support mechanisms. While some support schemes offer general support in order to assure competition between technologies and cost efficiency with respect to RES technologies, others offer technology specific support with the purpose of supporting specific industries, immature technologies or to ensure diversified RES technologies (Pade and Jacobsen, 2012).

As barriers related to differences in support schemes become less significant the less ambitious the cooperation is, we only consider the situation where two countries engage fully in a joint support scheme for all technologies. In the following we consider the barriers that may arise when agreeing on a common support scheme relative to the support schemes already implemented in the participating countries. We take the point of departure in two widely used support schemes, tradable green certificates and feed-in tariffs. Furthermore, we consider the issue of timing relative to the two support schemes.

3.1.1 Tradable green certificates

Implementing a tradable green certificate scheme for two or more countries covering all RES technologies is the most ambitious kind of cooperation countries can engage in, as the support mechanism itself exposes the technologies for competition and the support level will be determined on a market. These characteristics to the TGC is to a certain extent in contradiction to the characteristics of the other support schemes, that gives the opportunities to support specific technologies or differentiate the support level for the different technologies.

Feed-in tariff

Tradable green certificates and feed-in tariffs have different characteristics when it comes to the costs of support and the amount of RES installed. On the one hand, a list of conditions needs to be fulfilled in order to make TGC work well, such as liquidity and transparency in the market. On the other hand feed-in tariffs does not offer a predefined amount of volume and could potentially generate both excess and deficit relative to the target. For the investors the feed-in tariff represents a more secure investment as the revenue is certain, whereas TGC only will get that property if there is a commitment to increase the share of renewable over time.

As smaller investors normally prefer a feed-in tariff over TGC, the first will normally be better at supporting infant technologies and secure diversified RES technologies, whereas TGC are more appropriate if the target is to assure competition among technologies and cost-efficiency.

Tendering

Tendering works well with larger projects that require interaction with government/TSO, planning of infrastructure and localization of investment etc. whereas the application of TGC has competition among technologies and cost-efficiency in mind. The two support schemes thus have opposite points of departure, and combining the two would reduce the effectiveness of the TGC scheme.

Feed-in premium

Feed-in premiums and tariffs to a large extent have similar characteristics with respect to the costs of the support and the volume installed. Therefore, the contradictions present between feed-in tariffs and TGC is to a large extent the same for feed-in premiums and TGC.

Timing

One of the main issues related to cooperation is the lack of post 2020 targets (Pade and Jacobsen, 2012). As the commission has not yet defined targets for post 2020 there is uncertainty regarding the value of the installed RES after 2020. If there will be no future targets set, the value of the RES post 2020 is de facto zero.

A solution for a country being in deficit of RES potentials prior to 2020 (user country) seems to be to engage in cooperation with a country already using a green certificate scheme. However, in order to overcome the post 2020 target issue the user country has to engage in cooperation for a period beyond 2020 and the amount of quotas has to be adjusted accordingly. In this way the user country will own the RES capacity in the entire support period/lifetime of the technology and hence post 2020.

Case: Joint Certificate agreement – Sweden and Norway

Norway and Sweden has engaged in a common tradable green certificate scheme. Below we outline how the scheme is designed related to the post 2020 issue as well as the EU Directives.

<u>Main set-up</u>

In the power certificate system each power supplier should buy certificates from producers of renewable power corresponding to an increasing share of total sold power until 2020. After 2020 this share will decrease.

The power supplier should ask for an extra fee from the consumer – corresponding to the extra cost from the certificates – and it should be visual on the bill, what is the certificate price.

It is expected, that this extra system will result in higher prices for consumers and less income for power producers who produce power based on fossil fuel. As the price on the renewable certificates rise it is expected that the net power price decreases (that is power price before purchase of renewable certificate). How the bill will be divided in reality depends on the market and prices on power.

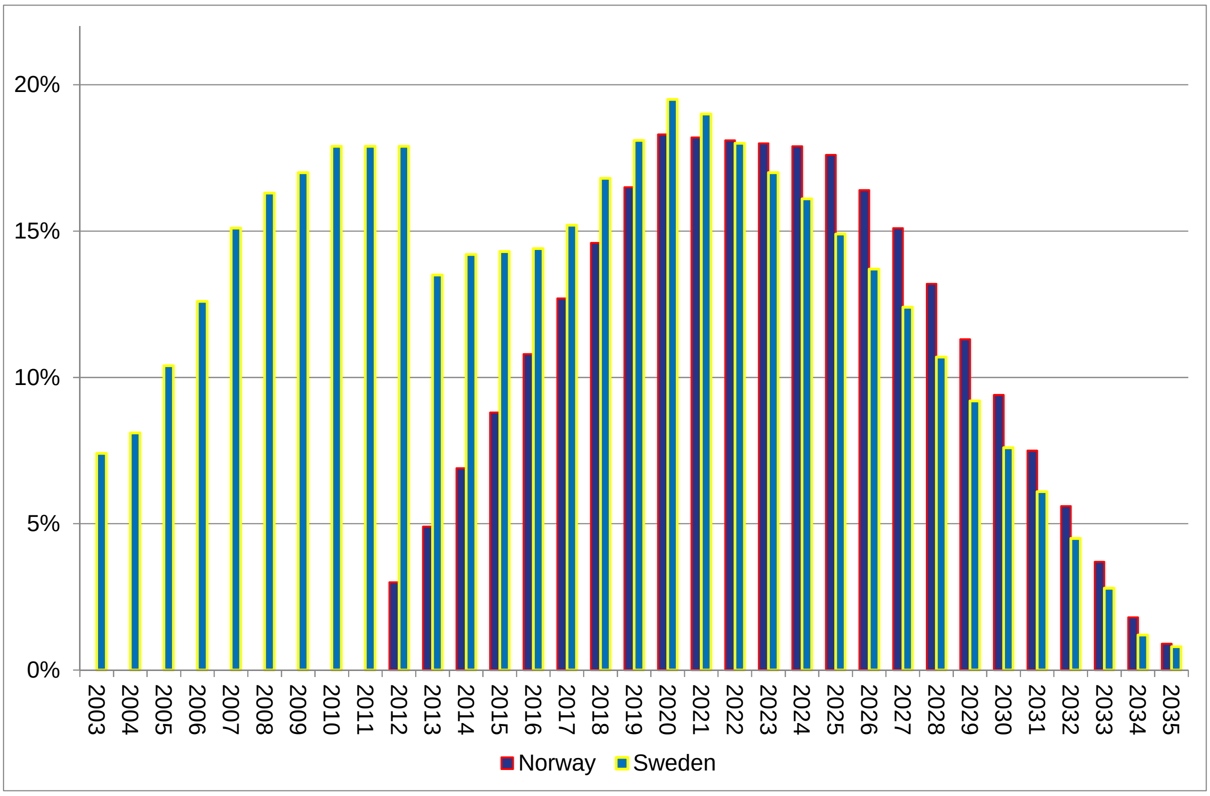
1 certificate corresponds to 1000 kWh renewable power. And each supplier of the certificates is approved as suppliers of new renewable production. The producers are approved in the home country (Sweden or Norway). Certificates will be assigned up to 15 years after initialization – though only until 2035. It is expected, that most of the extra renewable power will be produced from hydro-, wind and bio-power.

It is up to each country to decide who should buy certificates – and which kind of consumption should pay for the certificates. The quotas should be set with a linear escalation until 2020. The certificates should be annulled each year prior to the 1st of April.

What happens after 2020?

The certificate system is formed to hold from the period January first 2012 until December 31 2035, culminating in 2019 and 2020 where there should be the highest shares of renewable power production. As there was already a certificate system in Sweden since 2003, this system has to fit in the common system at the beginning of the period. After 2020 the renewable shares in both Norway and Sweden follows the same pattern and decreases.

Figure 3-1 Development of power quotas respectively Norway and Sweden in the period of 2012-2035



Source: Constructed from data in: "Lag (2011:1200) om elcertifikat; LOV 2011-06-24 nr 39: Lov om elsertifikater"

As a part of the system there is left room for banking, to stabilize the certificate price, so changes in weather conditions (level of water in the reservoirs, level of wind, level of temperature) does not affect the certificate price too much. This also gives room for investing at the right time. As banking was also a part of the old Swedish system, the quota level had to be relatively high on the Swedish side in the beginning of the period to keep certificate prices up.

Incentives from this solution – compared to EU in general:

As already mentioned, the EU system gives some challenges to the correct implementation of renewables, as support can be expected to culminate around 2020, but with no real security afterwards. In the Swedish-Norwegian-system, there will only be support in maximum 15 years, with a varying level of support, with potentially ever more support up until 2020 - depending on how investments are expected to evolve. After 2020 there will still be a period of high support (high share and therefore prices on the certificates) and then slowly support goes down. The shape of the curve, gives room for new investments as old capacity is wearing out, without the risk of no support right after 2020.

It also gives an incentive to be among the first movers, as total value of the certificates could be expected to be higher, with investments in for example 2016, than in 2022.

Compared to the general European model, this method gives first a higher degree of security – the electricity investors have a good picture today of what they have after 2020. Second it gives an incentive of building capacity which is depreciated relatively fast. After 2030 prices on certificates could be expected to be relatively low, and support therefore also relatively low. It would therefore be a good idea for investors, to invest in a technology which for the best part is depreciated after 10 years.

How the certificate system fits into the EU directive

Each country gets 50% of the capacity from renewable power production in the certificate system to report to the EU. And each country should pay 50% of the costs. The allowed technologies are based on the allowed technologies in the EU directive. In table 3-3 are pictured the different expected shares of renewable energy in the EU agreement. As showed, both Sweden and Norway has already high shares of renewables in their final energy consumption, and the extra growth is relatively small. It can also be seen, that Norway already has a higher share, than Sweden, and are not expected to grow as much.

Table 3-2 Share of renewable energy (in % of gross final energy consumption)

	2006	2007	2008	2009	2010	2020	Growth in RES
Sweden	42.7	44.2	45.2	48.1	47.9	49	15%
Norway	60.6	60.5	62	65.1	61.1	67.5	11%
Denmark	16.5	18	18.8	20.2	22.2	30	82%
Finland	29.9	29.5	31.1	31.1	32.2	38	27%
EU27	9	9.9	10.5	11.7	12.4	20	122%

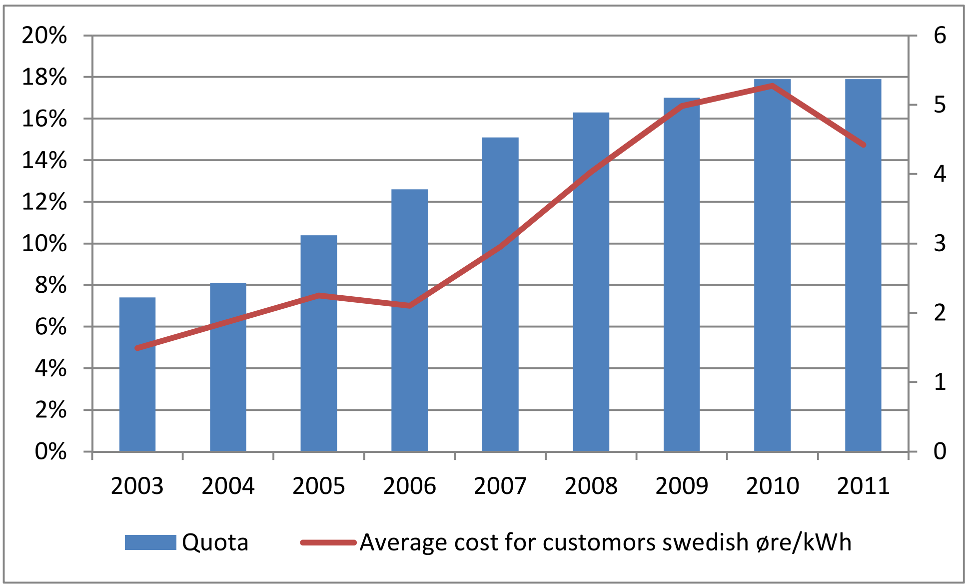
The joint certificate market is only on power, whereas the total share in renewables is for the whole final energy consumption. Both countries therefore, have to add with extra RES, though Norway might have to add with less, as their target is lower, than the Swedish target.

Division of costs between Sweden and Norway

Norway and Sweden takes each the same share of costs for the extra development – in 2020 there should be 26.54 TWh new renewable power production – 13.2 paid by Norwegian consumers and 13.2 paid by Swedish consumers.

In figure 3-2 is shown the historical development in average additional costs for Swedish consumers along with the Swedish power certificate system – ex vat and transaction costs.

Figure 3-2 Development of average additional costs for Swedish consumers along with the Swedish power certificate system



Source: Based on data in the Swedish "Elcertifikatsystemet 2012"

The graph shows, that costs follows the same trend as the share of renewables, though not completely. As this is only a short time serial it is difficult to make harsh conclusions, though it seems intuitive, that costs to a certain extent will follow the share of renewables.

<u>Other support-schemes in the set-up</u>
Overall the power certificates are expected to be enough support for renewables investments – and support from EU institutions should be combined with the certificate system. It is agreed thought that already existing support should be allowed to continue.
Any extra support to a given technology should be decided with the other part – if one part decides to give extra support – this technology should by default not be part of the certificate system.

By using this strategy, primarily developed technologies will be used in the certificate system, which also corresponds well with the overall setup. As both countries will probably not full-fill their whole renewable obligation within the certificate system, there will still be room for individual addition of renewables.

3.1.2 Feed in tariff

In the following we consider the implementation of a common feed-in tariff for two or more countries covering all RES technologies. The feed-in tariff has been widely used in EU countries and, relative to the TGC, feed-in tariffs are more simple and straightforward to implement. When considering the contradictions between the feed-in tariff and other support mechanisms only tradable green certificates seem to be in direct contradiction with the feed-in tariff.

Timing
Similar as for TGC the issue of post 2020 targets also counts for a joint project based on a common feed-in tariff for all the technologies. In order to assure the necessary investments in RES the support needs to be granted for the entire lifetime of the technology, or at least for a

period ensuring the investors receive a reasonable return on investment. Depending on the design of the joint support scheme the countries may jointly own the value of the RES for the entire lifetime of the technologies and will be able to use these rights for compliance with a future target.

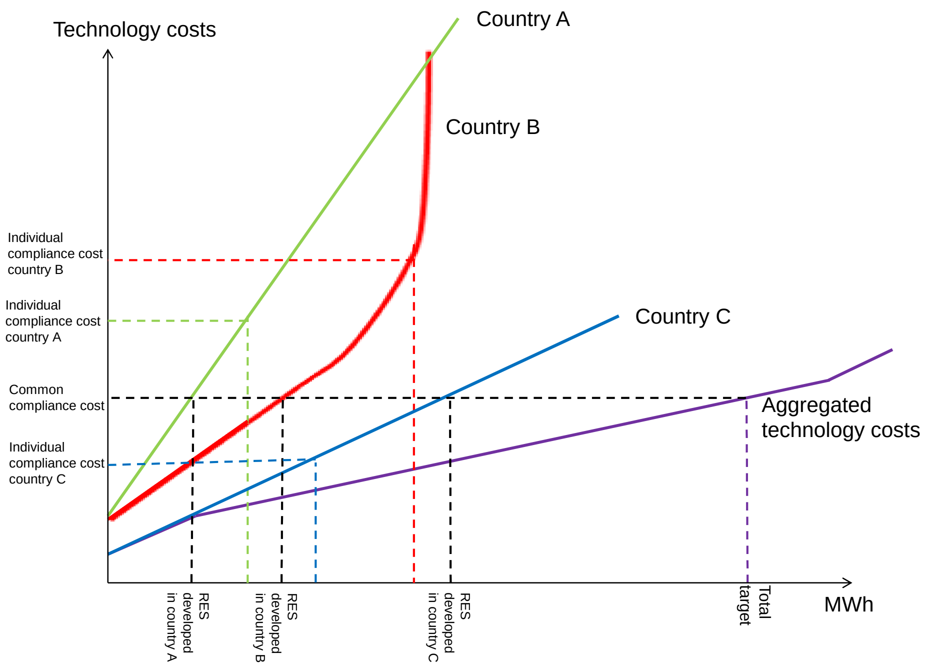
3.2 Compensatory challenges

As in the general case (Pade and Jacobsen, 2012) one of the main barriers to cooperation is the ability to design a compensation scheme, which takes all the costs and benefits from cooperation into account.

3.2.1 Direct costs and benefits

First and foremost, independent of the chosen support scheme, a fully integrated support scheme between two or more countries will lead to a common target compliance and hence the compliance costs will as a point of departure be the same for the three countries. In Figure 3-2 the individual target compliance and the resulting marginal costs are illustrated as well as the common target compliance and the common marginal compliance costs. The figure illustrates that the marginal compliance costs in the individual cases are higher for country A and B whereas the common marginal costs are higher than the individual marginal compliance costs for country C. In a common support scheme, in this case, country C will be worse off cooperating relative to individual target compliance.

Figure 3-2 Common marginal compliance cost and individual marginal compliance cost country A, B and C



In order for country C to engage in cooperation with country A and B, there needs to be some sort of compensation from country A and B towards country C. However, as the total compliance costs for the three countries are lower when they cooperate compared to the individual cases, there is room for bargaining.

Furthermore, as country C has the lowest technology costs a substantial share of the RES development is expected to take place in country C, and the “cheap” RES potential in country C will be exploited when complying with the targets of 2020. As there is insecurity regarding targets post 2020, country C may be reluctant to engage in cooperation making future target compliance even more costly.

3.2.2 Indirect costs and benefits

The indirect costs and benefits, explained in Section 2.3, relates to the effects on the power market, technological development, employment effects, health and environmental effects. Taking the point of departure in the illustrated example with three countries where the one country has substantial lower compliance costs compared to the other two countries, it is most likely that the majority of the RES will be developed there. In this case, the low cost country will probably experience indirect benefits in terms of technological development, employment effects and to a certain extent health effects. In Jacobsen et al (2012), Tantareanu (2012) and Santamaría and Caldés (2012) the magnitude of these effects have been estimated based on specific case studies and are found to be rather limited.

The host country will most likely experience long term negative effects on the power market through reduced incentives for investments in other technologies and the resulting loss of security of supply. In the short term more investments in RES will increase total capacity and thereby increase security of supply. This improvement will be less if the RES is uncontrollable RES as wind or PV. In the long term the reduced investment incentives due to lower wholesale power prices will lead to less conventional and controllable capacity investment. Total capacity may be unchanged or increased moderately but total security is reduced. These developments are only relevant if the additional RES is of considerable size compared to the total market capacity. For small shares of uncontrollable RES the net effect on security will be neutral or slightly positive.

3.3 Network regulation

Network regulation varies a great deal between member states from rate of return to incentive based price and revenue caps. The details in incentive regulation include numerous differences and the enforcement of regulation is not always effective. Network regulation has impacts on the incentives for networks to facilitate efficient connection of new technologies and network reinforcement (Ropenus et al, 2011). If national regulation allows networks to include reinforcement investments caused by renewable generation in their capital base and thereby revenue cap, then this cost will be borne by the network customers. The major uncertainty regarding the total network costs caused by additional renewable capacity connected relates to network reinforcement. Therefore the host country will have the best knowledge of this and assigning the reinforcement costs to the host country in cooperation will be the best way to reduce this uncertainty barrier. The connection costs will under a shallow cost regime best be assigned directly to the cooperation project investment costs. For a further discussion of these issues refer to Deliverable 4.2 of this project (Heinemann C, Bauknecht, 2012).

3.4 Institutional barriers

Different issues regarding legislation may constitute barriers for cooperation. First of all there is the question of how to structure the agreements legally, the resources used on lawyers, and how legal agreements are traditionally designed in the one country compared to the other country. These ‘transaction’ costs reduce the incentives to engage in cooperation with other countries. This type of transaction costs will be most significant for smaller projects and small projects will not have the ability to include costs for governmental agreements etc.

3.5 Solutions

The major barrier to a fully coordinated joint support scheme between two or more countries is the risk that the country with the lowest technology cost will experience a major cost in relation to cooperation in combination with a risk of even higher compliance costs for a possible future target. If there are excess resources available relative to 2020 targets, these are available for future target compliance for the low cost country. If these are used towards 2020 targets for another country through cooperation they will not be available at a later time and more expensive resources will have to be used at that time.

The positive indirect effects in terms of increased technological development and possible employment and health effects are most likely insufficient to compensate for these potential losses. One solution for the countries with the low RES costs is only to engage in less ambitious cooperation where only certain areas or certain technologies are part of the cooperation. However, in that case we approach the concept of joint project (see Section 4).

4 JOINT PROJECT COOPERATION

Joint project cooperation is the most flexible type of cooperation and the specific design can thus vary considerably. The main drawback is that the largest possible efficiency gains are not necessarily achieved and the transaction costs can be high. Because of the flexibility in design it must be expected that this mechanism will be the most widely used up to 2020, at least measured by the number of applications, but not necessarily by the amount of RES credits transferred.

In all cases the joint project cooperation require that governments interact in agreeing on the framework for cooperation if not also all the details in the projects. It is necessary to agree on the transfer of credits in 2020. Host country has to agree to transfer some of the credits generated within its border for the year. This means a statistical transfer has to take place in 2020. Risk can be put entirely on the user or the host country with regard to reaching the expected generation to transfer in 2020.

If compliance risk is on the **user** country it means that it will only receive a statistical transfer for the actual amount of RES credits generated from the project it has supported/acquired. The host country has to agree that it cannot count generation from the specific projects towards its own target. Logic therefore, would assume that all costs should be borne by the user country. Thus the necessary support costs for the RES investment should be financed by the user country. A simple solution would be just to make the user country undertake the entire investment in the host country. In that case the project counterpart implementation risk is eliminated for the host country.

In the more likely case that the user country is facing a private investor in the host country that should undertake the project investment and operation, support design becomes more important. Here support that incentivizes the actual generation in the year 2020 is the preferred option and the entire support could be given per unit of generation in the one year 2020. This will put a lot of risk on the **investor** that might prefer a support option similar to traditional long term quantity based support as feed-in tariffs or feed-in premiums.

If the two cooperating countries have agreed that the statistical transfer will take place not only in the year 2020 but for the actual lifetime generation of RES project it will be the obvious choice to use a feed-in premium support. The support risk for the **investor** in the host country will then have to be weighed with regard to having the national government or the user country government guaranteeing the support. Is the host country or the user country the most reliable counterpart in terms of complying with the agreed support? Investor opinion on this varies from case to case and depends on countries general economic conditions and the mechanism that finances the RES support. Sometimes the investors will be even more confident that the support is certain from the user country than from the national government. It is not unknown that a country directly or indirectly reduces the real support provided as for example a fixed feed-in tariff. This can be done directly (rarely) by changing the level of future feed-in tariffs for already deployed RES capacity or indirectly (more common) by adding specific taxes or grid user tariffs for existing RES capacity.

An agreement about joint project cooperation has to take into account both the direct and indirect effects as discussed in Chapter 2. Therefore joint project cooperation will include a comparison of the direct and indirect costs for the host and the user country. If it is found that there is some positive balance between the costs and benefits for the host country the agreement can progress without further compensation to the host country. This will however always be open for negotiation. Situations where there is some but not large positive net benefit for the host country is the best foundation for quickly agreeing and entering into joint project cooperation.

Examples of addressing and comparing these costs and benefits associated with joint project cooperation can be found in the three case studies D3.3-3.5, (Klinge Jacobsen et. al., 2012; Tantareanu, 2012; Santamaría & Caldés, 2012)

Table 4-1 provides an overview of the types of cooperation and when the joint project cooperation has its strengths.

The two last rows represent joint projects cooperation and they stand out as the type that is most promising in a short term time scale. The barriers resulting from changing existing support schemes and conflicting with national secondary objectives from support can be avoided by using the joint projects. National support systems can be maintained and credibility of government policies stability secured, but still allowing the achievement of some of the efficiency benefits of cooperation.

If used for smaller projects the transaction costs can be a barrier, but if these are considered pilot projects that could facilitate a later standardization and transfer to a cooperation type described as "joint project support framework" this barrier is not important.

Larger projects overcome the transaction cost barrier and even when there has to be a negotiation about total cost and benefits accounting and compensation between the two countries this is not a decisive barrier.

Countries that have a considerable expected RES deficit in 2020 or have excessive high cost of complying with the target in 2020 are most likely to engage in joint projects of larger size. Others may engage in smaller pilot projects in order to gain experience for future post 2020 use of cooperation mechanisms. For larger projects these will often require planning and licensing interaction with the host country. This may provide for using tendering/auctions for such projects. This approach has been further examined in (Klinge Jacobsen et. al., 2012) that look at joint offshore wind projects with tendering for exact amount of wind capacity at a specific area and giving specific conditions.

Table 4-1 Cooperation mechanism characteristics, barriers and solutions

Cooperation mechanism	Primary cost saving potential	Secondary benefits involved	Barriers for implementation	Solution for barriers	Possible time horizon for implementation
Harmonised joint support scheme	Large A full harmonised system without technology differentiation of support yields the highest efficiency gain	Larger markets, More competition, National secondary support objectives difficult to maintain Harmonisation in other market conditions and increased power market integration	Considerable time delays in legislation, Difficult to compensate directly the losers, National control of support policy reduced	Compensation mechanisms and cooperation on reaching secondary objectives (infant industries, employment and diversification of technologies), Allocation of net benefits to losers	Complicated and requires national legislation delays Long term option
Local/regional joint support scheme	Medium level Advantage for countries with shared/bordering resources	Maintained national support for not covered areas and technologies expand excess resources	Opposition to favoring investment in one area opposed to those areas covered by national scheme	Replicate one system from one of the cooperating countries – limited legislative delay	Medium term time scale
Joint projects cooperation	Small to medium advantage for few large projects	Maintain own support systems and secondary objectives	Transaction costs, Lack of transparency, Legal requirements because of lack of legislation	Target technologies with large project size	Short term time scale
Joint projects support framework	Medium	Maintain own support systems and secondary objectives	Transaction costs lower than for single project	Identify technologies/areas where standardisation easy and many small projects works better than a few large	Medium term time scale

As the fully harmonised joint support scheme includes the largest potential cost reduction in complying with RES targets an option that explores this without giving up national existing support schemes might be preferred in the short run. This could make the option of a joint projects support framework attractive. The time scale for such a framework is probably around 2016-2018 as some developments of standards and agreements between countries have to be made. Hereby this will not contribute significantly to the total compliance with the 2020 targets, but may provide a background for realizing higher RES targets after 2020 with lower costs than without cooperation.

4.1 Specific barriers to joint projects

Joint project cooperation first of all faces the common barriers that most renewables and small scale technologies also face. These are among others related to connection charges, connection procedures, delays and balancing charges as well as exclusion from ancillary market participation. We exclude these here as they are not specific to cooperation projects.

4.1.1 Transaction costs

Small cooperation projects will incur relatively high transaction costs if every time government to government negotiation has to take place. The length of such negotiation processes may be reduced due to previous experience in implementing such projects. If this part is settled there still remain legal issues regarding risk against the specific project developers and from project developers towards the user country fulfilling its long term obligations. Thus the user country has to guarantee to each small project that it will get the lifetime support for its annual generation.

The solution to the transaction cost barrier is thus to:

- Prefer large projects

or

- Standardise the project conditions and reduce risk elements

It is expected that the larger projects will be preferred first as the development of joint project support frameworks requires more time and involves more uncertainties. Larger projects are can be found in electricity and heat generation. In electricity this could comprise hydro projects, larger wind farms, larger CSP installations or biomass power plants. Also CHP plants based on biomass are relevant.
Standardisation of smaller projects is possible for some technologies where the balance of costs and benefits for the host country do not differ too much depending on the total volume of cooperation projects. This is not always the case as for example integration costs of intermittent renewable depend very much on the share that has to be absorbed in a local grid. If standardisation is done within certain limits for example through auctions or tenders for a specified total amount of capacity/generation then the variation of indirect costs can be controlled easier and the host country could take the risk of rising reinforcement/integration costs.

4.2 Simple setup for joint projects

The advantage of joint project cooperation is the simple implementation, flexible conditions and applicability in the short term as highlighted in Table 4-1.
Joint projects also have the flexibility that they can be implemented at varying scale. Therefore the possibility of pilot projects is attractive for countries a bit reluctant to move fully in this direction. The conflicting interest in the host country among investors, electricity consumers and other power generators can make changes in support and financing cumbersome. Joint projects avoid this. The existing renewable generators that receive support will not be discriminated against by new projects as they as investors will be fully eligible to propose or engage in the new RES projects under the cooperation.

4.2.1 No changes in national legislation

Joint projects can be implemented without having to modify national legislation. This is a major advantage for several reasons.

1. Timing is no constraint as projects do not have to wait for changes in legislation.
2. Secondary objectives in national energy policy can still be met.

Joint project cooperation requires no legal changes and national interest are not conflicting with the terms that the new projects will have. As a general rule the same regulation of connection charges, application procedures, balancing and controllability/disconnection ability and general corporate taxation schemes applies to these new projects. There should be no discrimination among host country and foreign country investors with regard to all these conditions. The support that is given by the user country to investors is open for all investors. There can be restrictions with regard to technology, siting, timing and operational limitations, but these shall be non-discriminatory.
With regard to secondary objective or indirect benefits of national support schemes these can be maintained under joint project cooperation. Support at high levels for RES expansion that is expected to create jobs and contribute to developing infant domestic industries can continue unchanged side by side the additional joint cooperation projects. It is fairly easy to avoid the selling out of cheap future RES options that might be needed by restricting the cooperation to higher costs technologies even though this policy will not necessarily be optimal. Thus political and public concerns for this development can be handled.

Joint projects are therefore the best candidate for using cooperation mechanisms in the short term. As such the major part of cooperation up to 2020 must be expected to be of the joint projects kind.

4.2.2 Directly negotiated compensation

Joint projects allow the cooperating countries to fix the quantity exchanged and to a large extent fix the risk sharing of not complying. Furthermore each individual cooperation project can design and agree on its own compensation for direct /indirect benefits and costs sharing. This can be extremely simple ex ante or depend on project implementation results and more complicated. However countries have to negotiate and agree on this for projects separately or for clusters of projects that are standardized. Where the balance of direct and indirect costs and benefits for the host country is slightly positive it should be relatively easy to negotiate a joint project without further compensation and to assign the entire project risk and compliance risk to the user country.

4.3 Local or regional cooperation projects

Joint project cooperation can take place between countries that are geographical neighbours or between countries far from each other. There is no specific barrier from being situated far from each other. As it is practically very difficult to assign specific transfer of electricity generation to all projects and especially smaller projects then the physical transfer option is always difficult to incorporate in a project. The most common solution will always be to entitle the investor to the electricity generation and the user country only the RES credits.
A situation that might facilitate adding benefits from differences in power market prices (need for capacity) will require that the cooperating countries are not too distant. Here we could suggest looking into local and/or regional cooperation projects.
When neighboring countries are considering joint project cooperation there might be very divergent technology potentials and costs that facilitate large efficiency gains. Exploiting much more renewables in one country at a fast pace may result in indirect costs that can be substantial from the power market. These negative effects can consist of building much more power capacity than needed resulting in falling power prices or it could be steeply rising integration costs from intermittent renewables. If the two countries are near this barrier (compensation requiring imbalance), this may be mitigated by cooperation projects where governments not only agree on the RES investment projects but also include electricity interconnection capacity investment in the

project. Additional interconnection may facilitate higher power prices in the host country as well as a lower necessary support for the RES investment. Such effects are found when the host country is or becomes the low price power market and the user country is the high price power market. This interconnection solution requires that we are dealing with relatively large cooperation projects and some time scale where interconnections can be established.

To illustrate the potential benefits of local/regional cooperation projects we now consider cross border or technology specific cooperation where the cooperating countries maintain their existing support instruments. The example is based on off-shore wind cooperation where investment costs are somewhat different for example due to water depth or just a lack of sufficient sites for wind farms in one country. Implementing a special cross-border offshore zone where a joint project support framework could be implemented is a promising option that bypasses the barriers concerning harmonisation of the entire support schemes in the cooperating countries.

The combination of electricity generation sold at one market (country) and the support provided partly by another country can be compensated by renewable credits. Such a scheme also has to cover the cost and benefits for the national power markets and include this in the compensation mechanism or the RES credits transfer price. Sharing the costs and benefits may involve swapping the receiver and provider of credits and support in time as discussed in 4.5. One country may face a RES target deficit in 2020 but expect additional domestic RES development after 2020. Similarly a country already exceeding the 2020 targets might want to secure credits for a future period, still allowing another country to earn the credits up to 2020. This could for example be included in a joint tendering procedure.

We now turn to a situation with two countries that are characterised by differences in power prices, support schemes (feed-in tariffs vs. tendering) and connection costs attribution. Figure 4-1 illustrates such a situation where it is evident that barriers for cooperation mechanism are very large especially for establishing full joint support cooperation.

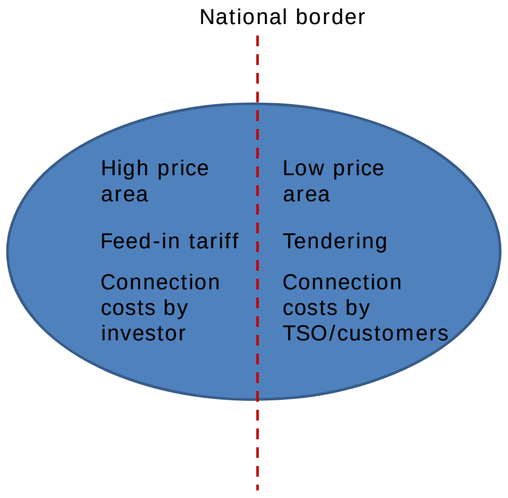


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Figure 4-1 Joining divergent power markets and support instruments

Figure 4-2 illustrates a possible design for a common technology-specific cross-border scheme: a neutral power price zone has been established, tendering is the chosen support instrument and transmission/interconnection costs are borne by the TSO in the high price area. This allocation of costs illustrates that the high price area receives the major power price reducing impact. RES credits and subsidy costs are shared equally. The alternating price area could gain some practical relevance in offshore grids (Neuhoff & Boyd, 2010) and if interconnector capacity is identical to both countries, this implies that always the lower of the neighbouring prices applies (Schröder, 2012). The characterisation as joint project cooperation is made due to the option to agree on the volume of the tendered RES. Volume will be known at time of agreement for both the participating countries and price only after each tender has been settled.

Another aspect is that in case of an interconnector failure, power would still be provided to a country that is involved in the support of the generation units. Contrarily, locations that are remote from one country, but close to another shore could be accessed from this other shore. Connection costs could be reduced this way by sharing capacity among 'foreign' wind farms and adjacent national farms under a joint project support framework.

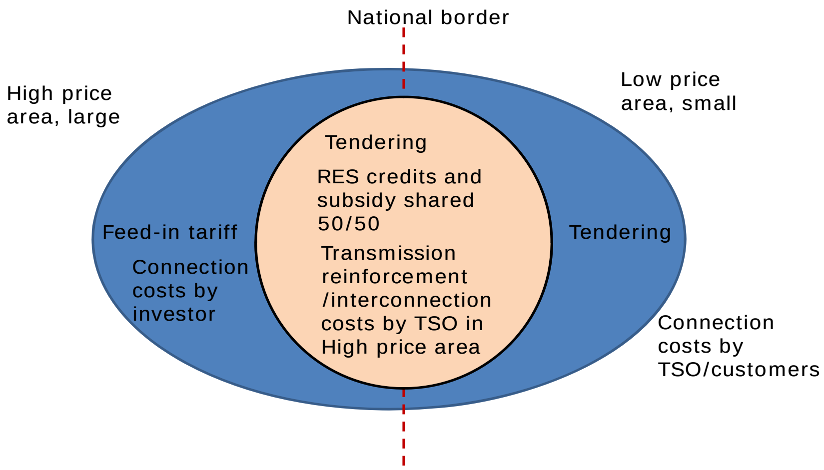

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Figure 4-2 Joint project/joint support schemes as a subset of support instruments in two or more countries

4.4 Technologies for joint cooperation projects

Any renewable technology could be considered for joint projects. As demonstrated in the D2.5 etc. there are however technologies that turns out to be specifically promising in terms of VoO's. These are wind energy, biomass and solar. Each of these can be found all over Europe, but they have their relative advantage (costs and potential) in different regions.

Technologies that can be treated in a standardized way and that have similar indirect effects independent of location within a host country are the easiest to use for joint projects. Joint project technologies that are small in scale have the advantage that they do not provide large indirect effects on power markets or in network integration costs. On the other hand they may face large transaction costs relative to the size of the capacity and investment. Wind energy projects on-shore are interesting in terms of low marginal costs, and as long as they are not implemented in large numbers have only limited effects on power markets, network integration etc. However the potential across Europe have been demonstrated to be rather small and there are large acceptance issues for onshore wind installations.

Off shore wind is mainly feasible as wind farms and well suited for cooperation projects as the potential is large and the transaction costs relatively low compared to stand alone on-shore turbines. The widespread use of tendering for contracts with developers of off-shore wind farms also contribute to the simplicity of this alternative as joint projects. It is relatively easy to link the project for one negotiated support cost with a corresponding fixed quantity of RES capacity and approximate generation for 2020. The risk with regard to developer compliance in setting up the wind farm as well as guarantying the support payment can be assigned to one of the parties or even split among host country and user country. The existing RES support system can remain unchanged and there will be no differentiation between off-shore projects included in joint project cooperation and other off-shore projects. The host country can decide on one off-shore wind

farms at a time and therefore cooperation comprising large amounts of wind power can be agreed and implemented gradually and also under different conditions as more experience is gained. Therefore joint project cooperation could involve a host in one region of Europe cooperating with a different region supporting their biomass based power generation at a lower support cost than they provide in their home country. This is an efficiency increase from the perspective of the user country and the EU as a whole. Joint project cooperation will normally comprise one or a limited number of technologies in contrast to full joint support cooperation that will comprise most of the renewable technologies.
Expected technologies for joint projects are those that are in the low to medium cost range. It will not necessarily be the cheapest options since these will be limited in volume and countries will be reluctant to give up these unless they are compensated.

4.5 Timing of target and exchange of future RES credits for 2020 credits

The RES targets for 2020 are established as renewable production as a percentage of total energy consumption in 2020 with some minor modifications. Therefore the targets do not specify that the capacity, (electricity and heat generation capacity) has to amount to the same percentage of the total capacity in these sectors. Thus a user country does not have to control (own) the generation rights from a certain RES capacity in a host country. A user country just needs to be able to account the RES generation for **the year 2020** towards its own target. Acquiring only the 2020 RES generation in a cooperation project can be considerably cheaper than acquiring the generation for the entire lifetime of the RES technology applied in the project.

A description of these fundamentally different types of cooperation are given here for power sector options and applied in the case study for wind D3.3 (Klinge Jacobsen et. al., 2012)

Cooperation between the user **and host country** includes two options**:**

I. User country acquire the full RES **capacity** credits necessary to generate for 2020 compliance: User country finances the entire support cost for lifetime of the RES capacity
Generation from the capacity counts towards the user country post 2020 targets (reduced risk)

II. User country acquires only the generation credits necessary for 2020 compliance.
Generation from capacity counts towards the host country future obligations. User country has the full risk on post 2020 compliance

It is quite possible that a country has an opinion about the future obligations that it will have to meet post 2020 with regard to increased RES targets. This country will be quite reluctant to give up cheap excess RES resources for another country compliance with its target. With this in mind it might alternatively want to swap credits to a user country in 2020 while receiving back the credits at a future time. If this is possible the cheap RES resource might be exploited before 2020 and not kept as a potential resource the host country can later exploit if RES targets are increased post 2020. Swapping of credits in time could thus facilitate the use of cooperation mechanisms today and thereby secure that we are exploiting the cheapest RES options first at the EU level. Using this swapping RES credits in time correspond to using option II above, which is the extreme version with just one year, namely 2020, for the user country and the remaining credits for the host country.

A similar argumentation relates to the situation where individual countries have more ambitious national policy targets for renewables beyond the 2020 EU targets. Such countries will be reluctant to enter into cooperation projects for 2020 since they want to exploit the same excess RES resources at a later time for fulfilling own domestic targets post 2020. Using option II in this case is also attractive and has been further analysed in the case study for offshore wind, (Klinge Jacobsen et. al., 2012).

The argument for the user country for using option II and swapping the credits is mainly the large cost saving up to 2020 and that it is expected that either post 2020 targets will not be very strict or cooperation mechanisms will be further developed such that future targets can also be met by acquiring RES credits from other countries at relatively low costs.

Furthermore the user country could be in a position where costs of national RES deployment is expected to become cheaper due to technological progress or other developments in for example overall heat and electricity demand. Higher electricity demand might make RES expansion cheaper.

Comparing the costs of acquiring credits for the year 2020 using option II will be considerably cheaper for the user country than option I. It could correspond to as little as the levelised costs for one year minus the expected average power market price, but must be expected to be somewhat higher as the host country should also have more than marginal benefits from entering into this cooperation. But this cost advantage comes with a considerably higher risk on complying with possible future RES obligations set by the EU.

Option I as the normal cooperation option will cover the lifetime of the project, for example 15 years with annual payments from user country to investors in host country of the agreed support amount. In return the user country get the RES credits generated in each year. The investors get additionally the market price in either the host or the user country depending on whether physical connection capacity is available or not. The specific support could also be designed as a fixed feed-in price where the user country receives both the credits and the electricity generation. This should however not affect the necessary amount of support to the RES investment.

In Option II only the RES credits for 2020 are traded. Therefore the transaction can be a simple one off payment to the host government, which guarantees the total support payment for the entire lifetime (support period) towards investors. The project implementation risk could be agreed to be entirely borne by the host country. The benefit of the host country taking the full risk is that it simplifies the procedures and reduces the risk of conflicting incentives. The host will have to be strict on the investor contract compliance and domestic procedures (TSO, environmental planning) that may otherwise delay the implementation. It is also an option to share the risk but that would naturally be more relevant where the credits swapping is not full or only takes place after some years. In this case it would require a more direct involvement in tendering procedures and contract negotiation for the host country.

The different options have very different risk profiles with regard to the post 2020 RES obligations. Option I provides the user country with the ability to count the full energy generation towards maintained or increased RES targets post 2020 for the lifetime of the RES technology. Option II leaves the user country with the challenge to comply with possible future RES targets from the EU. The higher risk associated with Option II is balanced by the cost advantage that could be as low as 5% of the costs from acquiring the lifetime RES credits from the capacity (Option I).

5 THE ROLE OF OTHER RES REGULATION TOOLS

The indirect effects of cooperation include the possible costs and benefits associated with emissions from energy use. Cost will be experienced by the user country that does not get the RES expansion which could have reduced environmentally harming emissions from the country's own electricity generation etc. Benefits for the host country correspondingly arise from the emission reduction from building additional RES capacity compared to the situation without cooperation.

Whenever there is a national or an EU level quantity based policy there might be interactions with the RES targets and their environmental effects nationally. This is for example relevant for the CO_2 targets under Kyoto.

When there is a binding CO_2 quota for the EU and a RES target at the same time the effect on carbon emissions of increasing RES targets will be zero in the short term and little even in the long term. Any increase in RES targets will reduce the cost of carbon emission allowances and therefore the abatement effort in other included sectors. This applies if the CO_2 quota under the European Emission Trading System has the same time horizon as a RES target. Tightening the RES targets in this case will only lead to other emitters expanding their carbon emission as it becomes cheaper. This could be switching from natural gas to coal in the power sector or other sectors that do not put so much effort into energy savings as they would have done otherwise.

If the CO_2 quota is not binding and allowances therefore near zero price then an increase in RES targets will also reduce the CO_2 emissions. This happens if the allowed CO_2 emission is higher than the expected emission with the cheapest technology, for example due to a much slower economic growth than expected when setting the CO_2 target. Emitting CO_2 from coal based power plants has no costs in this case and only the tightened RES target will reduce the generation from these coal plants as RES generation replace it at very low marginal costs. A RES target increase is here effectively the same as capping the generation from fossil plants if these have a large share of the power sector generation mix.

If there is no CO_2 target at all as was until recently very likely for 2020 then the RES targets effect on CO_2 will also be a reduction of emission. This applies when the RES generation substitute CO_2 emitting electricity generation or additional electricity generation replace fossil fuels elsewhere in the energy system.

6 CONCLUSIONS

Cooperation mechanisms can provide considerable cost reductions in meeting 2020 RES targets. Up to 2020 the timing suggests that the simplest solutions, maintaining individual country flexibility will be preferred.

The simplest cooperation solutions in terms of maintaining existing legislation and domestic support schemes, but adding new dimensions for support will be the easiest and fastest to implement. Here we suggest to look into larger projects for project based cooperation and the joint support schemes added on top of national support schemes for specific technologies or areas/regions.

Cooperation mechanisms involving countries, which have similar priorities and at the same time exhibit large differences in compliance costs are the easiest to implement. Large cooperation benefits and easy assessment of indirect costs and benefits provide the basis for arranging compensation such that the cooperating countries are certain that they will all gain. In this case even the harmonised single joint support scheme could be a solution to start moving towards, by defining compensation principles and methods and preparing the national markets for the change.

Joint project cooperation where there are both benefits from difference in RES technology costs and benefits from expected difference in power market prices and physical market transfer will have the best chances for being implemented. However negotiating the transfer price for credits in 2020 is difficult especially since the country binding targets post 2020 are unknown and the value of future generated RES credits therefore very uncertain. This may lead to a sub-optimal preference for projects with a short lifetime. Announcing some direction for the future binding targets of EU would improve on this situation and reduce this barrier for cooperation.

It is thus suggested that EU policy support the future cooperation by already now committing to future RES targets that will at least increase the RES shares somewhat even though the more ambitious targets cannot be agreed on yet.

In the longer term any cooperation could pave the way for further harmonisation of support schemes and cost efficiency in support even though this is not the main objective of cooperation now. As the regional or technology specific joint support scheme is an add on to a national support scheme this might provide a bridge to entering into full joint support scheme cooperation in the future when these limited schemes prove to be beneficial to all the countries participating.

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